The Pulkovo Program for Spectroscopy of Herbig Ae/Be Stars: 33 Years of Observations with the 2.6-m Shain Telescope of the Crimean Observatory

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Abstract. An overview of the results of spectroscopic observations of the Herbig Ae/Be stars at the Crimean Astrophysical observatory starting from 1986 in the framework of the Pulkovo program. The aim of the program was to study structural and kinematical properties of the circumstellar envelopes around bright objects from the catalogue of candidates to the Herbig Ae/Be stars by The et al. (1994). As a result, long-term spectroscopic monitoring of 9 Herbig Ae/Be stars have been carried out. Two main groups of the program objects can be distinguished: a) the yearly type (B0–B3) massive stars, and b) B9–A4 stars with signatures of dense outflowing matter on the line-of-sight between the star and the observer. The features of both groups as well of individual stars are discussed.

Keywords: stars: early-type; circumstellar matter; techniques: spectroscopic

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The objects from the first group of early-type stars demonstrate the most interesting and unexpected properties. We have revealed that B3e star HD 200775 is a double system with the orbital period $P = 3.68$ years (Beskrovnaya et al. 1994; Pogodin et al. 2000, 2004), see Fig. 1. We have opportunity to follow the process of the gaseous envelope dissipation around HD53367 (B0) and its new appearance during several months (Pogodin et al. 2006). It was established that both stages of this process start from the stellar surface and then expand toward the remote region (see Fig. 2).

Using photometric and spectroscopic data we have proved that the B2e star HD 52721 is a close binary system which contains two B-type components with

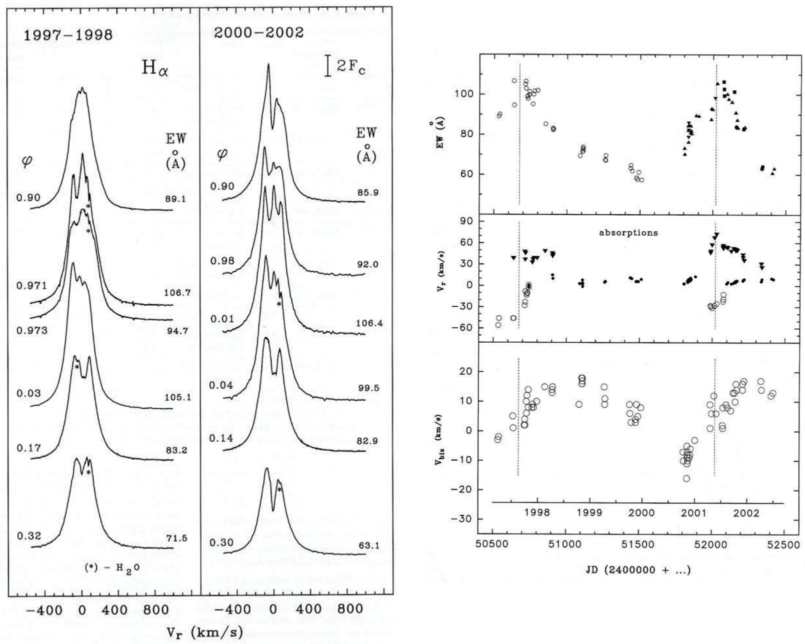

Fig. 1. *Left*: Typical emission Hα profiles of HD 200775 at different phases of activity (for $P = 1345$ days) during observing seasons 1997–1998 and 2000–2002. *Right*: Variations of different parameters of the emission Hα profile of HD 200775 in 1997–2003. *Top panel*: equivalent width EW; *middle panel*: positions of local absorption components; *bottom panel*: bisector velocity at the normalized intensity level 1.5–2.0 F_c. This parameter corresponding to the velocity of the star was used to obtain the orbital solution for HD 200775 as a binary system.

similar parameters and has the orbital period $P = 1.61$ days (Pogodin et al. 2011; Beskrovnaya et al. 2013; Pavlovskiy et al. 2015). The gaseous envelope of the system has an azimuthal inhomogeneity concentrated near the secondary star (Fig. 3).

The A-type Herbig stars with PCyg-type line profiles demonstrate variations in the form of emission profile transformation: PCygII – PCyg – III – single. On the time scale of hours-days such transformation can be explained by azimuthal inhomogeneities rotating in the envelope. On the time scale of months-years it is likely to be connected with latitudinal redistribution of the matter in the wind

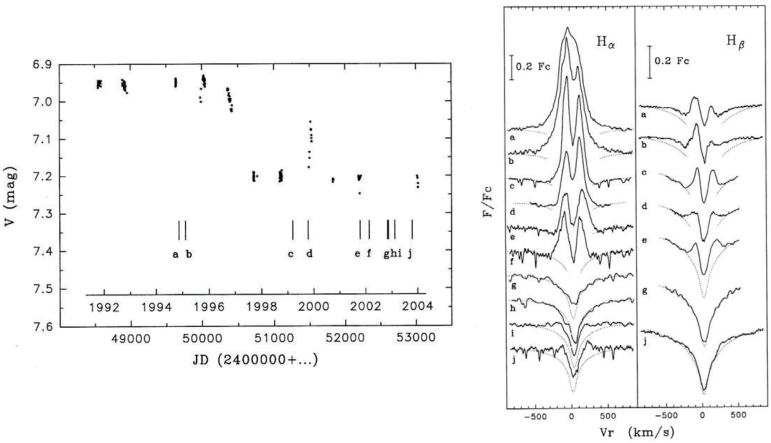

Fig. 2. *Left*: The light curve of HD 53367 in 1992–2004.
Right: The Hα and Hβ profiles variability in the spectrum of HD 53367 during the dissipation of its gaseous disk-like envelope and the consequent emergence of the new envelope.

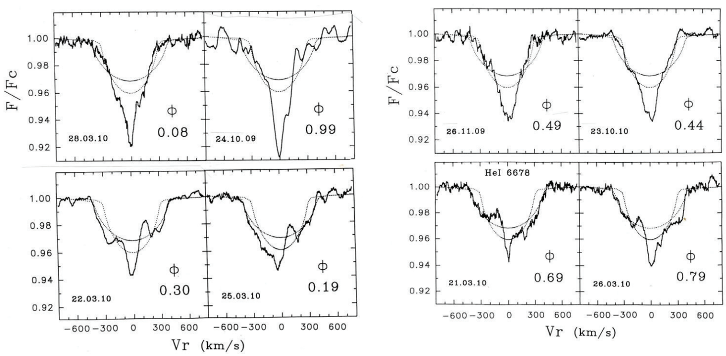

Fig. 3. Phase variations of the HeI 6678 line profile of HD 52721. At the phases of photometric minima the atmospheric background component is more narrow, and the circumstellar contribution looks as a symmetric absorption core. At the phases of photometric maxima the atmospheric component is wider, and the circumstellar component is seen as a weak double-peaked emission with variable V/R ratio. This ratio is less than unity at the phases $\Phi = 0.0$–0.5 (when the secondary moves away from the observer). $V/R > 1$ at the phases $\Phi = 0.5$–1.0 (when the secondary approaches the observer). It could be a signature of azimuthal inhomogeneity concentrated close to the secondary and rotating rigidly with the orbital motion of the system's components.

zone (Beskrovnaya et al. 1995, 1999; Beskrovnaya & Pogodin 2004; Pogodin et al. 2005, 2018, 2019; Kozlova et al. 2019)

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